CLAIMS:

1. A spiral wound membrane filtration element capable of being back-flushed comprising:
a permeate carrier sheet,
a membrane filter layer sheet adhesively bonded to the permeate carrier sheet, and having a support substrate, and a membrane film over the support substrate; and
a feed spacer sheet in between layers of membrane filter layer sheets;
wherein the support substrate has a Frazier air permeability between 0.1 and 10 cfm/ft;
wherein the membrane filter layer sheet is adhesively bonded to the permeate carrier with adhesive capable of retaining the bond during element back-flushing.
wherein the feed spacer sheet, the membrane filter layer sheets, and the permeate carrier sheet are wrapped around a permeate collection tube.

2. The element of claim 1 wherein the feed spacer sheet has a thickness between 0.02" and 0.10."

3. The element of claim 2 wherein the feed spacer sheet has a thickness between 0.04" and 0.06."

4. The element of claim 1 wherein fluid is capable of flowing through the support substrate and the membrane film does not delaminate from the substrate during the back-flushing cycle.

5. The element of claim 1 wherein the membrane filtration element utilizes a micro-filtration process.

6. The element of claim 1 wherein the membrane filtration element utilizes an ultrafiltration process.

7. The element of claim 1 wherein the membrane filtration element utilizes a nanofiltration process.

8. The element of claim 1 wherein the membrane filtration element utilizes a reverse osmosis process.

9. The element of claim 1 wherein there are multiple layers of the membrane filter layer sheets, feed spacer sheets, and permeate carrier sheets wrapped around the permeate collection tube.

AMENDED SHEET

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10. The element of claim 1 wherein the membrane filter layer sheet is adhesively bonded to the permeate carrier sheet with adhesive having an overlap shear strength of at least 300 psi.

11. The element of claim 10 wherein the adhesive is manufactured by E.V. Roberts of Culver City, California, model number 1752.

12. A method of making a back-flushable spiral wound membrane filtration element having a filter layer and a permeate collection tube, the method comprises:

forming a membrane filter layer sheet with a support substrate having a Frazier air permeability between 0.1 and 10 cfm/ft^2;

cutting the membrane filter layer sheet to a desired length;

placing a cut piece of a feed spacer sheet on top of the membrane filter layer sheet, the width of the feed spacer sheet being approximately half the width of the membrane filter layer sheet;

folding the membrane filter layer sheet over the feed spacer so that the feed spacer sheet is sandwiched between two layers of the membrane filter layer sheet;

attaching a center side part of a permeate carrier sheet to the permeate collection tube;

applying an adhesive seal on the permeate carrier sheet along sides other than the center side part;

positioning the membrane filter layer sheet-feed spacer sheet sandwich over the permeate carrier sheet such that the adhesive seal bonds the membrane filter layer sheet to the permeate carrier sheet; and

wrapping the permeate carrier sheet, the membrane filter layer sheet, and the feed spacer sheet around the permeate collection tube.

13. The method of claim 12 further comprising preventing feed solution from entering the permeate collection tube.

14. The method of claim 12 wherein the back-flush, pressure-resistant adhesive is manufactured by E.V. Roberts of Culver City, California, model number 1752.

15. A membrane filter layer sheet for a spiral wound membrane filtration element capable of being back flushed, the filter sheet comprising:

a support substrate; and

a membrane film over the support substrate;

wherein the support substrate has a Frazier air permeability between 0.1 and 10 cfm/ft^2.

AMENDED SHEET

16. The membrane filter layer sheet of claim 15 wherein the support substrate comprises a non-woven fabric.

17. The membrane filter layer sheet of claim 15 wherein the membrane film is cast on top of the support substrate to form an asymmetric membrane filter layer sheet.

18. The membrane filter layer sheet of claim 17 wherein the support substrate has a thickness between 0.002" and 0.008."

19. The membrane filter layer sheet of claim 18 wherein the support substrate has a thickness between 0.003" and 0.005".

20. The membrane filter layer sheet of claim 17 wherein the support substrate has a Frazier air permeability between 1.5 and 3.0 cfm/ft^2.

21. The membrane filter layer sheet of claim 17 wherein the support substrate has a weight between 20 and 100 gm/yd^2.

22. The membrane filter layer sheet of claim 15 wherein the membrane film comprises a polymeric material.

23. The membrane filter layer sheet of claim 15 wherein the membrane film is encased around the support substrate to form a homogenous membrane filter layer sheet.

24. The membrane filter layer sheet of claim 23 wherein the support substrate has a thickness between 0.001" and 0.005."

25. The membrane filter layer sheet of claim 24 wherein the support substrate has a thickness between 0.002" and 0.004."

26. The membrane filter layer sheet of claim 23 wherein the support substrate has a Frazier air permeability between 0.5 and 1.0 cubic feet per minute per square foot.

27. The membrane filter layer sheet of claim 23 wherein the support substrate has a weight between 20 and 100 grams per square yard.

28. A method of creating a permeable back flushable membrane filter layer sheet comprising:

placing a casting solution of a certain thickness on a passing support substrate with a Frazier air permeability between 0.1 and 10 cfm/ft^2;

controlling the thickness of the casting solution on the support substrate through use of a mechanical device for dispensing the casting solution; and

immersing the substrate with the casting solution into a quench bath to allow removal of casting solution after an air quench time that allows formation of a thin skin on the support substrate.

29. The method of claim 28 wherein the mechanical device is one of a doctor blade and a precision slot coater.

30. The method of claim 28 wherein the quench bath is water.

31. The method of claim 28 further comprising treating the permeable membrane filter layer with one of heat, additional rinsing, drying, and additional coating.

32. The method of claim 28 wherein the casting solution is polymeric.

33. The method of claim 32 wherein the solvent into which the polymer is dissolved is one of dimethylformamide, 1,4 dioxane, acetone, and n-methyl pyrolidone.

34. The method of claim 33 wherein the polymers are one of polyethylene, polypropylene, polysulfone, polyamides, polypheylene esters, polyethersulfone, polysulfonamides, polyvinylidene fluoride, cellulose acetate, cellulose, polyacrylonitrile, and other film forming polymers.

35. The method of claim 28 wherein the casting solution is heated.

36. The method of claim 35 wherein the casting solution is applied at an elevated temperature in the range of 0°C to 70°C.

37. The method of claim 36 wherein the casting solution is applied at an elevated temperature in the range of 15°C to 40°C.

38. The method of claim 28 wherein the viscosity of the casting solution is between 100 and 1000 centipoise.

39. The method of claim 38 wherein the viscosity of the casting solution is between

250 and 350 centipoise.

40. The method of claim 28 wherein the membrane filter layer sheet is homogenous.

41. The method of claim 28 wherein the membrane filter layer sheet is asymmetric.

42. The method of claim 28 wherein the air quench time has a duration between 5 and 60 seconds.

43. The method of claim 42 wherein the air quench time has a duration between 20 and 30 seconds.

44. A spiral wound membrane filtration element capable of being back-flushed comprising:

a permeate carrier sheet;

a membrane filter layer sheet adhesively bonded to the permeate carrier sheet with model number 1752 adhesive manufactured by E.V. Roberts of Culver City, California, the membrane filter layer sheet having a support substrate, and a membrane film over the support substrate; and

a feed spacer sheet in between layers of membrane filter layer sheets;

wherein the feed spacer sheet, the membrane filter layer sheets, and the permeate carrier sheet are wrapped around a permeate collection tube.

45. A back-flush system for a back-flushable spiral wound membrane filtration element comprising:

feed solution for the filtration element from a source;

a feed pump for pumping and pressurizing the feed solution from the source through the filtration element;

a feed pipe through which the pressurized feed solution flows to the element;

an element pressure tube wherein a first portion of the feed solution permeates the membrane filtration element as a permeate, and a second portion of the feed solution does not permeate and exits the membrane filtration element as a concentrate;

a feed diverter valve for controlling flow from the feed pipe to the pressure tube;

a source of compressed gas capable of back-flushing the membrane filtration element; and

a concentrate diverter valve for controlling the flow rate of concentrate out of the exiting pressure tube.

46. A method of cleaning the spiral wound membrane filtration element comprising:

applying pressurized feed solution having solids to an outer surface of a membrane filter

layer sheet in the element;

passing a portion of feed solution through the membrane filter layer sheet as a permeate;

retaining a portion of the feed solution solids in pores of the membrane filter layer sheet;

removing the non-retained solids from the element with the remainder of the feed solution;

allowing the permeate to flow in a first direction through a permeate collection tube of the element; and

introducing a pressurized back flush fluid with a pressure that exceeds the feed pressure, on a periodic basis, into the permeate collection tube in a second direction opposite the first direction to dislodge a substantial portion of the retained solids on the pores of the membrane filter layer sheet.

47. The method of claim 46 further comprising:

pumping the feed solution from the source using a feed pump;

pressurizing the feed solution in the pump;

pumping the pressurized feed solution through the filtration element using the feed pump;

controlling flow from a feed pipe to the element using a feed diverter valve;

controlling the flow rate of concentrate out of the exiting the element using a concentrate diverter valve;

controlling the flow rate of concentrate out of the concentrate diverter valve using a concentrate valve;

holding permeate for the back-flush step using a permeate accumulator; and

controlling the flow of permeate out of the permeate accumulator and the flow rate of the backflush gas while back-flushing using a permeate diverter valve.

48. The method of claim 46 wherein the pressure on the back-flush gas is controlled by a gas regulator; and the back-flush pressure is greater than the feed pressure on the element by between 10 and 30 psi.

49. The method of claim 46 wherein the pressure from the back flush fluid on the element is between 5 and 100 psi.

50. The method of claim 49 wherein the pressure from the back flush fluid on the element is between 20 and 60 psi.

51. The method of claim 46 wherein the back flush fluid comprises at least one of compressed gas, air, nitrogen, permeate, and cleaning solution.

52. The method of claim 46 wherein the back flush fluid comprises permeate followed

by compressed air.

53. A back-flush system for a spiral wound membrane element comprising:

a feed tank having feed solution;

a permeate collection tube placed in the feed tank, wherein the permeate collection tube includes a spiral wound membrane element having a permeate carrier sheet, a feed spacer sheet, and a membrane filter layer sheet with a supporting substrate and a membrane film superimposed on the supporting substrate;

a bubbler having bubbles acting as turbulence promoters at the surface of the membrane filter layer sheet for reducing the boundary layer thickness at the surface of the membrane filter layer sheet, and creating a convective flow of feed solution from the bottom through the top of the element, and returning back to the bottom;

a source of pressurized back flush fluid used in forcing permeate from a permeate accumulator and back flush fluid back to the element; and

a vacuum system having a vacuum for creating the driving pressure to force the feed solution into the element thereby creating permeate.

54. The back-flush system of claim 53 further comprising:

an air pump for compressing gas for the bubbler; and

a permeate diverter valve, wherein the permeate diverter valve is capable of controlling permeate flow and reversing the permeate flow to back-flush any foulants from the surface of the membrane filter layer sheet.

55. The back-flush system of claim 54 further comprising a cycle of back flushing;

wherein the duration of the back flush cycle is 5 to 30 seconds;

wherein in between back flush cycles, the permeate diverter valve is activated to return the system to extracting permeate from the feed solution.

56. The back-flush system of claim 53 wherein the back flush fluid comprises at least one of compressed gas, air, nitrogen, permeate, and cleaning solution.

57. The back-flush system of claim 53 wherein the back flush fluid comprises permeate followed by compressed air.

58. The back-flush system of claim 53 wherein the vacuum is in the range of 5 to 29 mm Hg.

59. A method of back-flushing the spiral wound membrane element through a back-

flush system comprising:

placing a spiral wound membrane element into a feed tank;

promoting turbulence at a surface of the membrane filter layer sheet through a bubbler having bubbles which are capable of:

reducing a boundary layer thickness at the surface of the membrane filter layer sheet;

creating a convective flow of pressurized feed solution from a bottom through a top of the element; and

returning the feed solution back to the bottom of the element; and

introducing on a periodic basis a pressurized back flush fluid, with a pressure that exceeds the feed pressure, into the element in a direction from top to bottom of the element to dislodge a substantial portion of feed solution solids retained on pores of the membrane filter layer sheet.

60. The method of claim 59 further comprising:

compressing gas for the bubbler using an air pump;

creating the driving pressure to force the feed solution into the element thereby creating permeate using a vacuum system having a vacuum;

directing the flow rate of permeate out of the permeate accumulator and the flow rate of gas out of the tank while back-flushing using a permeate diverter valve;

activating a permeate diverter valve allowing back flush fluid to enter the element to back-flush the feed solution solutions foulants from the surface of the membrane filter layer sheet in the element.

61. The method of claim 59 wherein the pressure on the back-flush gas is controlled by a gas regulator; and the back-flush pressure is greater than the feed pressure on the element by between 10 and 30 psi.

62. The method of claim 59 wherein the pressure from the back flush fluid on the element is between 5 and 100 psi.

63. The method of claim 62 wherein the pressure from the back flush fluid on the element is between 20 and 60 psi.

64. The method of claim 59 wherein the back flush fluid comprises at least one of compressed gas, air, nitrogen, permeate, and cleaning solution.

65. The method of claim 59 wherein the back flush fluid comprises permeate followed by compressed air.